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POSSIBILITY OF USING A HIGH-PRESSURE PNEUMATIC PUMP IN THE PORCELAIN INDUSTRY

S. I. Burdyugov[1] and G. P. Tyurin[1]

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The advantages and disadvantages of using a high-pressure pneumatic pump at porcelain and insulator works are discussed. The testing results of a prototype pump are described.

Porcelain and insulator works currently use imported hydraulic membrane pumps for pumping and pressing of porcelain suspensions.

Thus, the Bogdanovichskii Farfor Works (Sverdlovsk Region) and ELIZ JSC (Perm) use MP 7.1/20 pumps produced in Germany and Ukraine. These pumps are equipped with safety valves limiting the pressure up to 2.0 MPa (20 kgf/cm^2). The pumps are actuated by an electric motor of power 7.5 kW and force impacts are implemented via a wedge-belt transmission, a worm reduction gear, a crankshaft, a piston, a working fluid, and a membrane. The pump weight is 1600 kg and its overall dimensions are 1650 × 1290 × 1680 mm. The acquisition of these pumps is problematic due to their high cost.

Therefore, the Iskra Research and Production Association executed an analysis of pumping and pressing of porcelain suspensions using pneumatic membrane pumps. After theoretical research, design documents were issued and two prototypes of pneumatic high-pressure membrane pumps NSM 50–20 were produced for trial performance at the Bogdanovichskii Farfor Works.

The NSM 50–20 pump has the following advantages compared to an MP 7.1/20 pump:

– its weight is 200 kg (8 times smaller);
– it does not require an electric power supply;
– it is explosion-proof;
– it operates using the compressed air system available at the factory (0.25 – 0.60 MPa);
– no safety valve is present;
– its sizes are smaller (685 × 440 × 1426 mm)
– it is simple to repair.

The pump design (Fig. 1) ensures the operation of two working chambers restricted by lids *1 – 4*. The chambers are divided into two spaces by flexible membranes *5* and *6* with a rigid center. The flexible membranes of different diameters are rigidly fixed at the ends of the rod *7*.

The spaces *A*, *B*, and *C* are power (air) cavities and the space *D* is the pressure (working) cavity. The pressure cavity has an inlet pipe *8* and an outlet pipe *9* with valves and a receiver *10* with a pressure gauge *11* to reduce the pressure pulsation of the medium pumped and to control pressure. The pump is brought into action by compressed air that is fed from a pipeline through connection *12* in turn to the cavities *A*, *C*, and *B*.

The reciprocating motion of the rod with the membranes is provided by a distribution unit *13*. As the rod moves toward cavity *D*, excessive pressure is developed in its work space, due to which the pumped air is squeezed out via the outlet pipe.

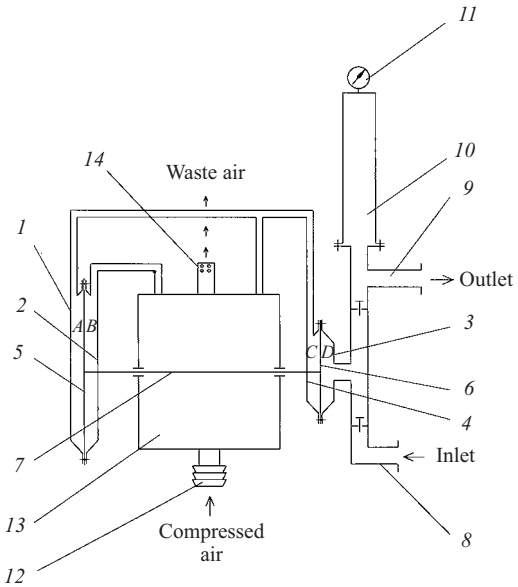

Fig. 1. Pneumatic pump design.

[1] Iskra Research and Production Association Joint-Stock Company, Perm, Russia.

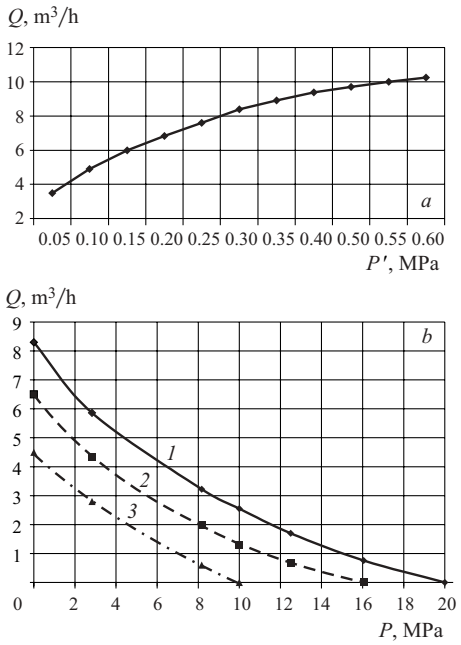

Fig. 2. Water supply Q depending on pressure P' (*a*) and back-pressure P (*b*) of compressed air: *1*, *2*, and *3*) $P' = 0.3$, 0.2, and 0.1 MPa, respectively.

As the rod moves toward the space *A*, rarefaction is created inside the work space *D* and the pumped product is sucked in. The waste air is released via silencer *14*.

The pump design to the maximum possible extent includes parts of other pneumatic membrane pumps of various standard sizes developed by the Iskra Research and Production Association.

The pump manufacturers carried out testing to check the dependence of the water supply on the pressure and counter presser of compressed air. The testing results are shown in Fig. 2

After testing, one pneumatic membrane pump was delivered to the Bogdanovichskii Farfor Works, where it was used to pump a porcelain suspension to a filter-press of the molding division and the low-temperature porcelain division. In the course of trial performance the pump pumped the suspension to the filter press and compressed cakes with the required properties.

The testing revealed some problems that can be solved by improving the pump design. Thus, pressure pulsation was registered in operation, which led to the destruction of the working membrane. A preliminary analysis established that such pulsation is due to the single direct-acting pump design and can be prevented by transforming it into a double-acting pump. In this case the quantity of the mixture pumped could be doubled.

In general the results obtained at the Bogdanovichskii Farfor Works confirmed the feasibility of using a high-pressure pneumatic membrane pump to pump porcelain suspensions and to compress cakes to a prescribed moisture level required for further production of porcelain or other ceramic articles.